US007249291B2

(12) **United States Patent**
Rasmussen et al.

(10) **Patent No.: US 7,249,291 B2**
(45) **Date of Patent: Jul. 24, 2007**

(54) **SYSTEM AND METHOD FOR RELIABLY COMMUNICATING THE CONTENT OF A LIVE DATA STREAM**

(75) Inventors: **Jens Rasmussen**, Copenhagen (DK); **Amin Shokrollahi**, San Jose, CA (US); **Soren Lassen**, San Francisco, CA (US); **Gavin Horn**, San Diego, CA (US); **Vivek Goyal**, Berkeley, CA (US); **Barry Dobyns**, Los Gatos, CA (US); **Michael Luby**, Berkeley, CA (US)

(73) Assignee: **Digital Fountain, Inc.**, Fremont, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 517 days.

(21) Appl. No.: **10/367,573**

(22) Filed: **Feb. 14, 2003**

(65) **Prior Publication Data**

US 2003/0226089 A1 Dec. 4, 2003

Related U.S. Application Data

(60) Provisional application No. 60/357,443, filed on Feb. 15, 2002.

(51) **Int. Cl.**
H03M 13/05 (2006.01)

(52) **U.S. Cl.** **714/701**

(58) **Field of Classification Search** 714/701, 714/784

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,568,614 A 10/1996 Mendelson et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 96/34463 A1 10/1996

OTHER PUBLICATIONS

P.A. Chou, A. Mohr, A. Wang, S. Mehrotra, "FEC and Pseudo-ARQ for Receiver-Driven Layered Multicast of Audio and Video," pp. 440-449, IEEE Computer Society, Data Compression Conference (2000).

Primary Examiner—Stephen M. Baker
(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

(57) **ABSTRACT**

A method for communicating the content of a live data stream to a receiver using a plurality of channels comprising two encoder channels used to encode the live data content prior to transmission. Initially a plurality of segments of a live data stream are received, wherein each segment contains segment data. A forward error correction algorithm is applied to each segment's data, thereby producing FEC-encoded segment data. The FEC-encoded segment data is contained within an FEC-encoded block, resulting in a corresponding plurality of FEC-encoded blocks being generated. Each FEC-encoded block is copied to a sub-channel on both a first encoder channel and a second encoder channel, resulting in a plurality of FEC-encoder blocks residing on the first and second encoder channels. The first and second encoder channels differ in the number of sub-channels they contain (interleaving depth), and accordingly the arrangement of the FEC-encoded blocks in the first and second encoder channels are different. A first cross-section of the FEC-encoded segment data contained within the FEC-encoded blocks resident in the first encoder channel is added to a first transmit block T_0. Similarly, A first cross-section of the FEC-encoded segment data contained within the FEC-encoded blocks resident in the second encoder channel is added to a second transmit block T_1. The first and second transmit blocks are then communicated to the receiver.

13 Claims, 17 Drawing Sheets